

Executive Summary

The Grazing and Pasture Technology Program (GAPT) is a multi-partner, province-wide organization with the overall goal of improving and sustaining Saskatchewan rangeland and pasture resources through comprehensive extension activities and services. The program started on November 1, 1993 and ended on March 31, 1997. GAPT was funded mainly by the Canada-Saskatchewan Agricultural Green Plan Agreement and was delivered by the Saskatchewan Stock Growers Association (SSGA) and the Extension Branch of Saskatchewan Agriculture and Food (SAF).

Program staff made a total of 3881 contacts with individual producers through farm calls, office visits, phone calls or mailed information. Field calls constituted a significant portion of the contacts averaging 214 per year for a total of 642 field calls. Those calls often involve significant fieldwork and range/pasture planning assistance.

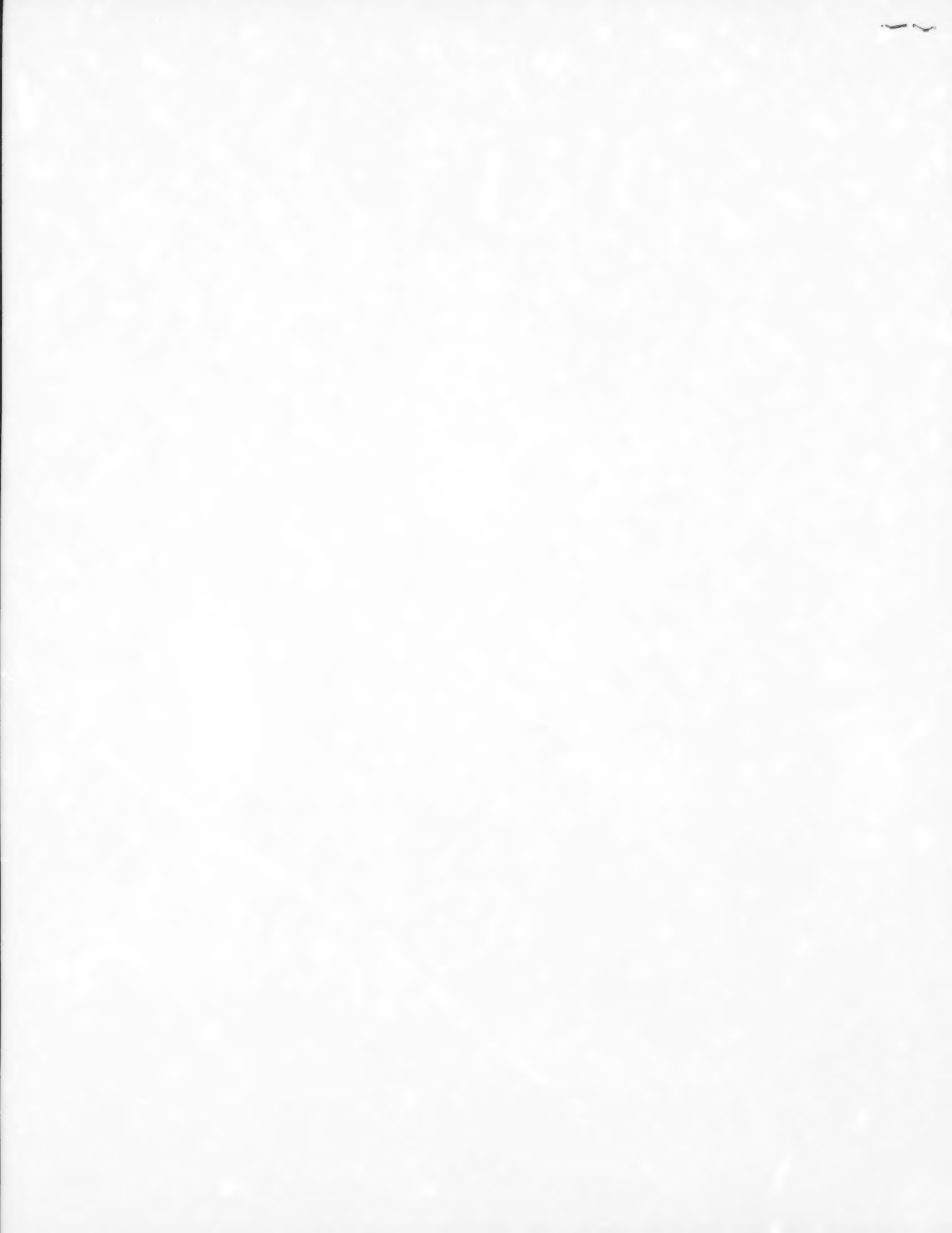
GAPT has organized and/or resourced 170 extension events, mostly in cooperation with the Extension Service Branch of SAF. The events included conferences, workshops, seminars, field days and field tours. Attendance varied with type of event and topics and ranged from less than 10 participants, as in kitchen-table Ranch/Farm Planning meetings, to more than 270 participants at the conference "Total Ranch Management in the Northern Great Plains". In total, the events were attended by 3811 participants.

Exhibitions and trade shows represented an important extension opportunities. Staff manned GAPT display at 27 exhibition and agricultural fairs. At those events there were 1422 visitors with diverse backgrounds, interests and geographic origins

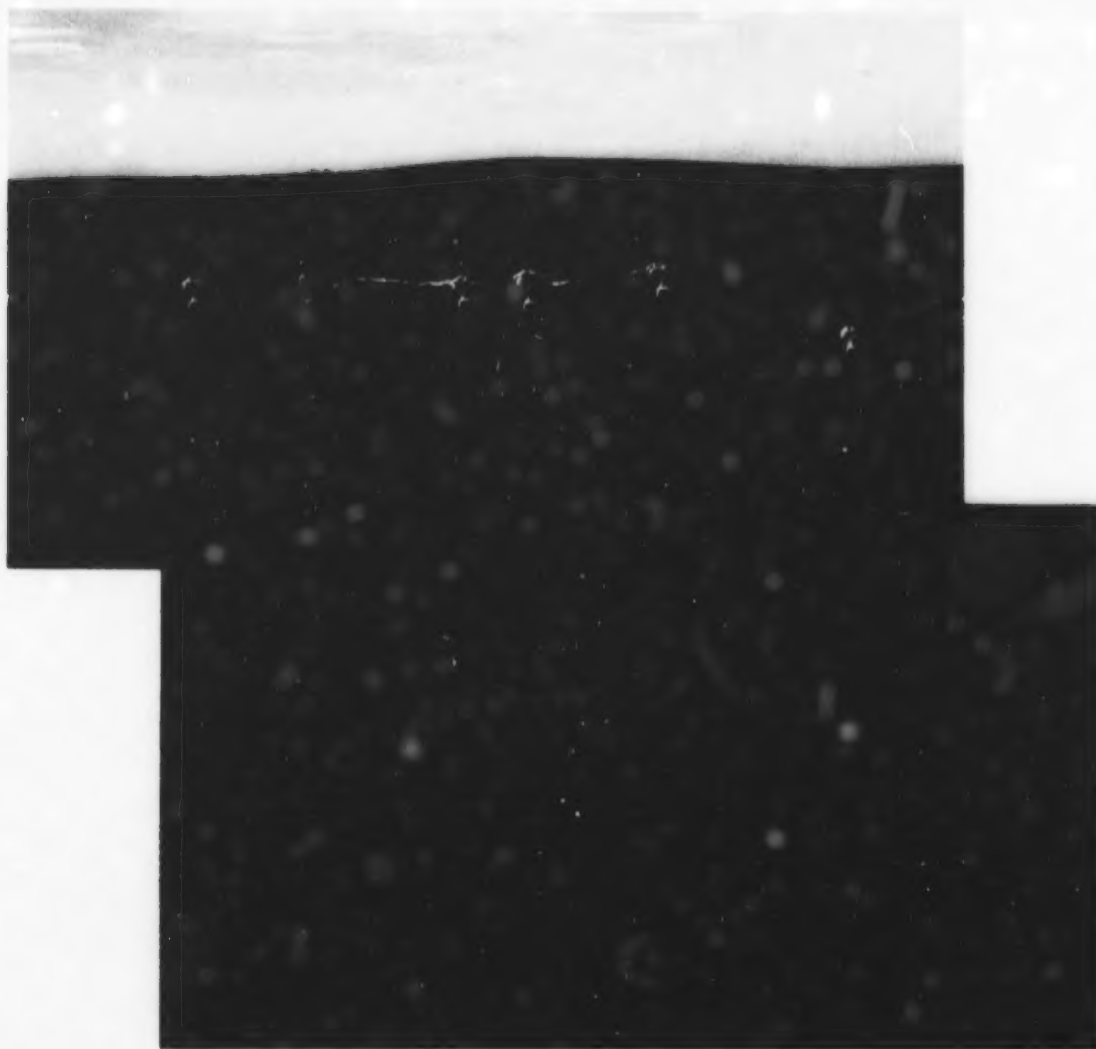
The Program published 8 issues of the Grazing gazette. The 12-page Gazette contained rangeland and pasture management and improvement articles contributed by GAPT Staff as well as guests from other organizations such as Agriculture and Agri-Food Canada Research Centres and Saskatchewan Agriculture and Food. The Gazette was mailed to a mailing list of 9000 people, mostly producers. This publication represented an important communication channel with both producers and professionals.

Another way the Program responded to producers' needs for information was through the development and publication of extension materials or TV and radio broadcasting. Fifteen extension publications were developed and made available free of charge to producers and others with interest in rangeland and pasture management. With the help of SAF's Extension Research Unit, some of our publications were placed on the Internet. In addition, there were more than 100 newspaper articles and radio or TV spots.

The Program had achieved its extension objectives and acted effectively as a catalyst for significant change in rangeland and pasture management. Examples of the Program's Impact on the livestock industry are discussed. Recommendations for future programming are provided.



REJUVENATION OF TAME FORAGES: SOUTHERN SASKATCHEWAN



Published by
Grazing and Pasture Technology Program (GAPT)
Regina, Saskatchewan
September, 1999

ACKNOWLEDGEMENTS

*This publication was prepared by: Bob Springer, Southwest Rangeland Agrologist,
Grazing & Pasture Technology Program, Swift Current, Sk. September 1999*

Manuscript formatting was completed by Marilyn Phillips. (GAPT), Regina, Sk.

Thanks are owed to the following people for their valuable comments and suggestions made on the first and second drafts of this publication:

*Zohier Abouguendia (Grazing and Pasture Technology Program, Saskatoon)
Pat Gerwing (Saskatchewan Agriculture and Food, Swift Current)
Jim Graham (Saskatchewan Agriculture and Food, Swift Current)
Lynn Grant (Rancher, Val Marie)
Dennis Haak (Prairie Farm Rehabilitation Administration, Rosetown)
Lorne Klein (Grazing and Pasture Technology Program, Weyburn)
Bart Lardner (Western Beef Development Centre, Saskatoon)
Jim Pratt (Saskatchewan Agriculture and Food, Swift Current)
Mike Schellenberg (Semi-arid Prairie Agriculture Research Centre, Swift Current)
Lloyd Thompson (Rancher, Carnduff)
Michel Tremblay (Provincial Forage Specialist, Saskatchewan Agriculture & Food, Regina)
John Waddington (Semi-arid Agriculture Research Centre, Swift Current. Retired)*

Photographs: Zoheir Abouguendia, Trevor Lennox, Jim Pratt, Bob Springer

TABLE OF CONTENTS

INTRODUCTION	2
WHEN IS REJUVENATION NECESSARY	3
IDENTIFYING CAUSES OF REDUCED FORAGE PRODUCTION	4
REJUVENATION METHODS	6
-Breaking and Re-seeding	6
-Mechanical Disturbance of Soil	7
-Fertilization	9
-Improved Grazing Management	13
-Herbicides	15
-Sod-Seeding	16
-Over-seeding	18
-Mowing	19
COSTS AND BENEFITS OF REJUVENATION OPTIONS	21
FUTHER READINGS AND REFERENCES	25

INTRODUCTION

Seeded perennial forages are an increasingly important resource for the agriculture industry in Saskatchewan. The number of acres of tame hay and pastures in the Province has increased by over 40% in the last decade.

A large portion of this increase was a result of the 'Permanent Cover Program' introduced by PFRA in the late 1980's. The purpose of that program was to encourage the seeding of perennial forages on land deemed unsuitable for annual crop production.

Also, the increase in grain freight rates since the elimination of the rail freight subsidy known as the 'Crow Rate', has encouraged increased forage production and expansion of the cow-calf sector.

Approximately six million acres or 10% of our agricultural land base is now seeded to tame perennial hay and pasture.

Because the productivity of a seeded perennial forage stand declines over time, periodic rejuvenation may be required. Rejuvenation is considered to be any treatment that is applied to an existing forage stand in an effort to increase productivity of the land. This could mean

increasing forage yield, forage quality or both.

According to a survey conducted by the Grazing and Pasture Technology Program (GAPT) in 1996, rejuvenation of tame forages is of great interest to livestock producers. Thousands of acres of tame forages in southern Saskatchewan are not producing up to their potential and producers are looking for the best methods to address this problem.

This publication brings together currently available information on the impact of various rejuvenation methods for dryland seeded perennial hay & pastures in southern Saskatchewan.

It is hoped that by using this publication as a resource, forage producers will be better able to choose and apply rejuvenation methods best suited to their operation.

This publication addresses forage rejuvenation in the Brown and Dark Brown soil zones of southern Saskatchewan. A similar publication, *Rejuvenation of Tame Forages: PARKLANDS*, discusses rejuvenation in the Parkland region of Saskatchewan.



WHEN IS REJUVENATION NECESSARY?

Newly established perennial forage stands have relatively high production and low maintenance costs once properly established.

The productivity of these stands tends to decline over time due to a number of factors. Some decline in productivity cannot be prevented even with the best management.

At some point, forage production will no longer meet minimum expectations based on previous years production and production achieved by neighbours on similar land. This is when the cause(s) of the decline in productivity should be identified and appropriate steps taken to improve forage production.

A publication titled '*Initial Stocking Rate Recommendations for Seeded Forages in Saskatchewan*' provides guidelines for expected forage production for

tame pastures and a method for assessing the condition of tame pastures (Table 1).

By keeping records on forage production or grazing days and using the above publication to compare the suggested stocking rates with actual stocking rates, it is possible to get some idea of the condition of the forage stand and whether or not rejuvenation should be considered. The objective is a stand in good to excellent condition.

When stands are in fair condition, a change in management and/or some form of less-expensive rejuvenation can return the stand to good condition within two or three years.

Forage stands that are in poor condition usually require more expensive rejuvenation methods and take longer to return to good condition.

Table 1. Seeded Pasture or Hayland Condition Classes

Condition	Criteria
Excellent	1. At least 90% of the production coming from desirable species. 2. Vigour of desired species high. 3. Density of desired species is moderate (optimum). * maintain management practices.
Good	1. 75-89% of production coming from desirable species. 2. Vigour of desired species is high. 3. Density of desired species is moderate (optimum). * maintain management practices.
Fair	1. 50-74% of the production coming from desirable species. 2. Vigour of desired species medium to low. 3. Density of desired species too low or too high. * requires rejuvenation and changes in management.
Poor	1. Less than 50 % of the production coming from desirable species. 2. Vigour of desired species low. 3. Density of desired species too low. * requires major rejuvenation and changes in management.

*Modified from G. Ehlert, Alberta Agriculture, Food and Rural Development, 1990.

IDENTIFYING CAUSES OF REDUCED FORAGE PRODUCTION

Once it is determined that the productivity of a forage stand is not acceptable, the next step is to identify the most probable cause(s) of the reduction in forage yield and/or quality. This is very important because it will help determine which rejuvenation method(s) are most likely to return the productivity of the land to the desired level for the least cost and with the least risk (Figure 1).

For this step, consultation with a professional Agrologist specializing in forage management is recommended.

Reduced forage production can be a result of many factors:

- 1) decline in soil fertility.
- 2) unfavorable weather, particularly drought, untimely rainfall or frost.
- 3) soil-related problems due to salinity, texture, poor water infiltration, or poor drainage.
- 4) long-term management problems which have resulted in the loss of desirable species and invasion of undesirable species.

Often, it is a combination of these factors that results in a significant decline in forage production.

Weather, unfortunately, is beyond our control. It is important to recognize when low forage production is due to weather-related factors. When this is the case, if the desired plant population is adequate, no rejuvenation is necessary.

When weather does not appear to be a factor in low forage production, other possible causes must be considered. Low soil fertility and improper grazing

management are the two most likely causes of declining forage production where weather is not a major factor.

Different forage species have different characteristics that affect their grazing tolerance, ideal season of use, nutrient requirements, moisture requirements and high/low temperature tolerance. Knowledge of these characteristics is important when trying to determine the cause(s) of declining forage production.

Collection and analysis of soil samples and examination of past weather conditions and stocking rates will help to determine the cause(s) of declining forage production and some possible solutions.

It is very important to consider the whole farm or ranch when making a rejuvenation decision. Declining productivity of a forage stand does not always require the use of high disturbance rejuvenation methods. Determine forage needs and if they are being met or exceeded, 'rest' may be the most economical option for your operation.

Remember that forage species in tame forage stands are often not as well-adapted to a site as plant species native to that site. The process of natural succession may favour an increase in well-adapted grasses, forbs and shrubs. Sometimes good management can prevent these problems.

Two examples of this situation are:

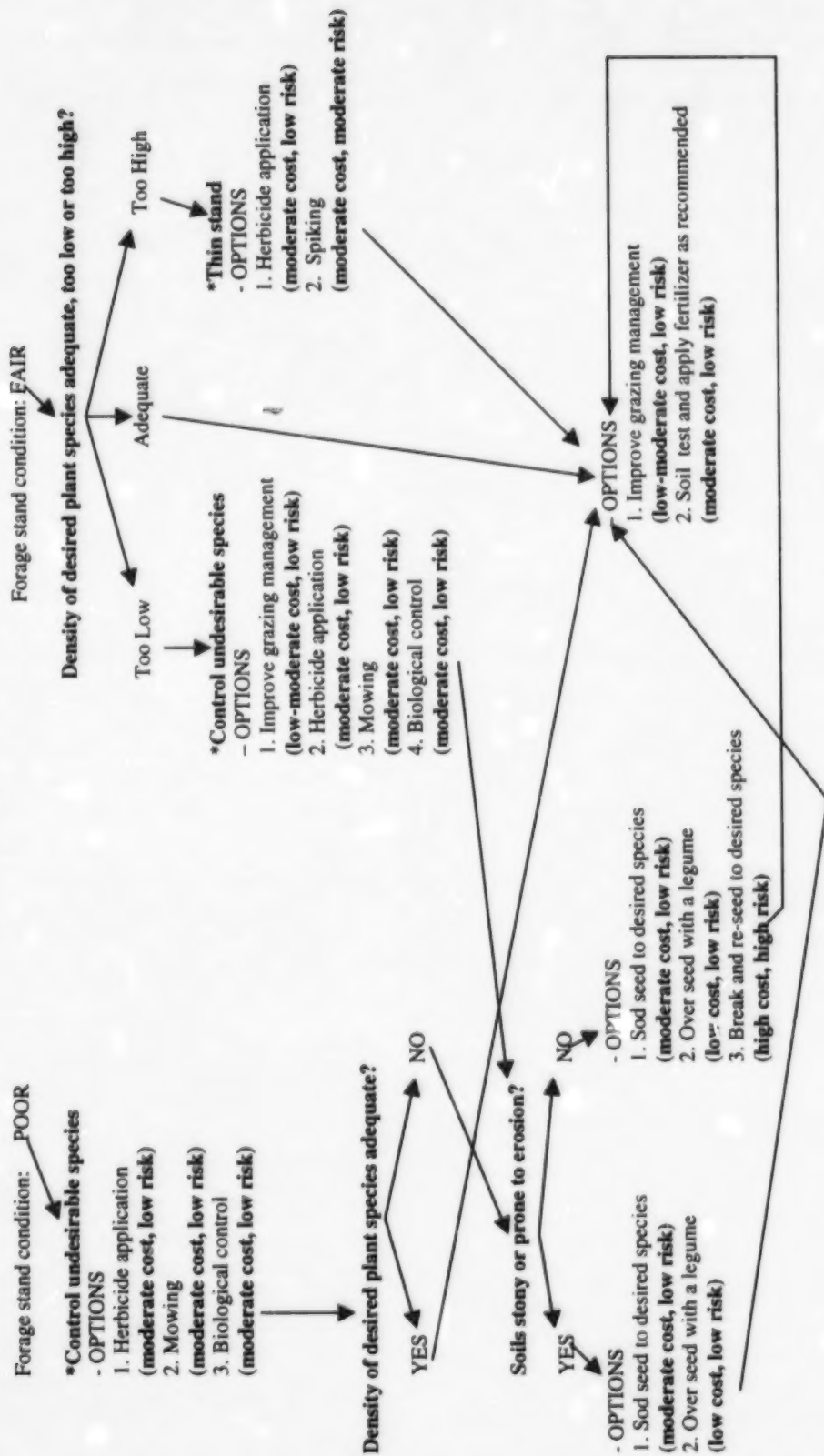
- 1) invasion by pasture sage into poorly managed crested wheatgrass or Russian wildrye pasture on dry sites.
- 2) invasion by bluegrass into hayland or tame pasture on moist sites: difficult to prevent with good management.



Producer and Agrologist assessing a forage stand.

Figure 1. Rejuvenation Decision - Making Flow Chart Based on Field Observations

Low Forage Production



* When planning rejuvenation treatments that will reduce short-term forage production, it is important to apply these treatments on only a small portion of forage acres in any given year to minimize the loss of forage production.

REJUVENATION METHODS

BREAKING AND RESEEDING

Description of Method

- Breaking and re-seeding is one of the most commonly used forage stand rejuvenation methods in southern Saskatchewan.
- Involves using a disc or cultivator to remove an existing forage stand and summerfallowing or cropping the land for a season or two before re-seeding forages.
- Breaking is commonly done in the fall. The land is often farmed for a year or two and re-seeded to forages in the fall or the following spring.
- Re-seeding forages into standing stubble has become common practice with the growing popularity of high-clearance seeding implements.

Implications of Using this Method

- 1) At least one year forage production is lost when the land is cultivated and re-seeded.
- 2) If weather conditions are not favorable, it can take more than one year to re-establish the forage stand and possibly more than one seeding operation.
- 3) **On sandy soils and/or rolling land, the risk of severe wind and water erosion is high using this rejuvenation method.**
- 4) Nutrients are released into the soil as the dead plant root material is decomposed. New seedlings can access this flush of available nutrients resulting in vigorous growth and improved forage production once established.
- 5) This release of nutrients will also be used by germinating weeds which will compete with forage seedlings in the establishment year.
- 6) Useful when a change in forage species mix is desired.

Changes in Plant Species

- In the year forages are re-seeded, weed populations can become quite high and may delay or prevent successful re-establishment.
- Most producers will cut and bale the weeds early in the season to minimize competition with forage seedlings.
- Most establishment - year weeds are annuals and their populations drop dramatically the year following



Broke forage stand.

seeding. They are not a problem if forage establishment is successful.

- Land can be seeded to different forage species if desired.

Effect on Forage Yield

- Most studies show that forage production was increased significantly for only a couple of years after breaking and re-seeding. Production declines rapidly and long-term forage production was not improved, unless a legume was introduced (Figure 2).

Effect on Forage Quality

- Forage quality or protein content will be improved following re-seeding as nitrogen is released into the soil by decomposition of organic matter following cultivation.
- This improvement in quality is usually short lived as the additional soil nitrogen supply is soon removed by grazing or haying.

Frequency of Treatment

- Because of the high cost and risks associated with breaking and reseeded, it should only be used when the success potential of the other rejuvenation methods is low.

Combination of Treatments

- Combining fertilization with breaking and re-seeding should improve the long-term forage yield and quality. See 'Fertilization' section for more details.

When and Where to Use

- Breaking and reseeded is usually done on a forage

stand that is in poor condition.

- **Breaking and re-seeding perennial forage stands is**

one of the most expensive and risky rejuvenation methods. It should only be used as a last resort, especially on fragile soils.

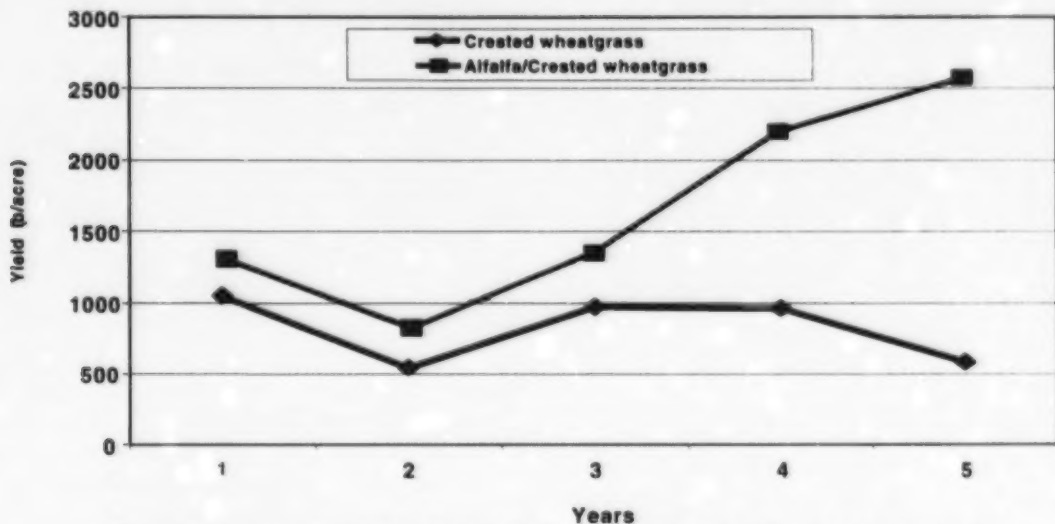


Figure 2. An example of the effect on forage yield including a legume in a grass stand. (Agric. Canada Public. 14731E).

MECHANICAL DISTURBANCE OF SOIL

Description of Method

- A tillage implement is used to disturb 30-50% of a perennial forage stand to a depth of 3-6 inches.
- This disturbance increases the decomposition of forage root material, releasing nutrients (mainly nitrogen) into the soil making them available for plant use.
- Given sufficient precipitation, this release of nitrogen, will result in a burst of grass growth similar to using fertilizer.
- Implements used include: cultivators with one to four-inch spikes; rotary harrows; or rotary plows such as the Aerway®.
- No more than 30% of the stand should be disturbed if it is the only treatment. If over seeding is done then up to 50% of the stand can be disturbed.
- If spiking is used, the land will be very rough and may have to be leveled with a drag or land roller.



Rotary harrow on an alfalfa/brome stand.

- Harrowing to level land after spiking is not recommended as it may result in too much damage to the forage stand.
- More than one mechanical disturbance in any given year is not recommended as the surviving plant population may be too low to give the desired increase in production.

Implications of Using this Method

- 1) Forage production will be reduced in the year of treatment and in dry years, depending on severity of disturbance.

- 2) Potential increase in forage production after treatment year if moisture is favorable.
- 3) Rough land may hinder grazing livestock, saddle horses, or harvesting equipment.
- 4) Creates potential sites for soil erosion and for invasion by undesirable plant species.
- 5) Potential increase in forage production is short lived as liberated nitrogen is quickly used by plant growth.
- 6) May damage legumes in pure or mixed stands. Creeping rooted alfalfa may benefit from mechanical disturbance.
- 7) May improve rate of water infiltration into the soil.

Changes in Plant Species

- Sod-forming grasses such as smooth brome grass will decrease in density in the year of treatment, but will recover to pre-treatment levels in the year following treatment.
- Bunch grasses can be thinned using spiking so it should only be considered on very dense stands on good soils.
- Pure tap-rooted alfalfa stands should not be spiked or rotary harrowed as it may cause excessive thinning, resulting in lower productivity and stand life.
- Productivity of tap-rooted alfalfa-grass mixed stands may also be negatively affected by mechanical treatments (Table 2).

Table 2. Effect of mechanical disturbance on alfalfa-brome grass hay yield. (3-year total)

TREATMENT	FORAGE YIELD LBS/AC (DM)
Check	6000
Spike and harrow	4400
Rotary harrow	4300

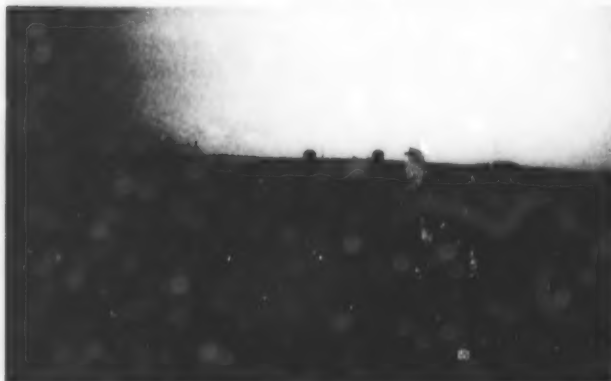
*Sask. Ag & Food, Lambert Worms, Lloydminster, 1994-96.

- **The soil disturbance caused by spiking or rotary harrowing provides a good site for establishment of undesirable plants.** This is most serious in dry years following mechanical disturbance but may only be temporary, provided the undesirable plants are annuals and the perennial forages are vigorous enough to provide competition.
- If undesirable perennial plants invade the site following mechanical disturbance, control measures may have to be applied before perennial forage production will improve.

Effect on Forage Yield

- This treatment results in an accelerated release of

nitrogen into the soil from decomposing plant organic matter.



Invasion of pasture sage following disturbance

- The forage stand will respond best to the increased nitrogen when there is good available moisture. The better the growing season rainfall in the year of treatment and subsequent years, the greater the yield improvement.
- **In the year of treatment, there is usually a reduction in forage yield.** This is because the tillage operation stresses the forage plants, especially in dry years. It also takes time for the soil microorganisms to free up the nitrogen. **A yield increase from mechanical disturbance is usually not seen until the year following the treatment.**
- **In most cases, by the second year following treatment, little yield improvement remains.** Figure 3 gives an example of long-term effects.

Effect on Forage Quality

- As with any treatment that increases available nitrogen to grass plants, mechanical disturbance will usually result in an improvement in forage quality. However, this quality improvement is short lived, usually lasting only a year or two, and is also moisture dependent.

Frequency of Treatment

- Because the positive effects of mechanical soil disturbance usually only last for a year or two it may be tempting to repeat the disturbance every two or three years. This is not recommended as the yield and quality improvement will be reduced and the stand may be weakened allowing invasion of undesirable plants and increasing the risk of soil erosion.
- **Treatment should not occur more often than every 5 - 7 years.**

Combination of Treatments

- Many studies have combined mechanical disturbance like spiking with fertilization and over-seeding.
- Seeding a legume such as alfalfa or sweet clover following spiking has resulted in yield and quality improvement but only after several years and where growing conditions were good (Figure 3). The existing stand has to be sufficiently suppressed to decrease competition for establishment of a new species to be successful.
- Research has shown that fertilizer alone improves forage yield as much as a combined spiking and fertilization treatment (Figure 3).

When and Where to Use

- Soil disturbance may not provide any benefit to legume stands and in fact may be detrimental. The additional nitrate nitrogen released into the soil as a result of the tillage may reduce symbiotic nitrogen fixation by legumes.
- If mechanical disturbance is used, the operation should be done as early in the spring as possible for the best chance of yield improvement.
- There should be good soil moisture at the time of treatment to ensure the stand recovers from the

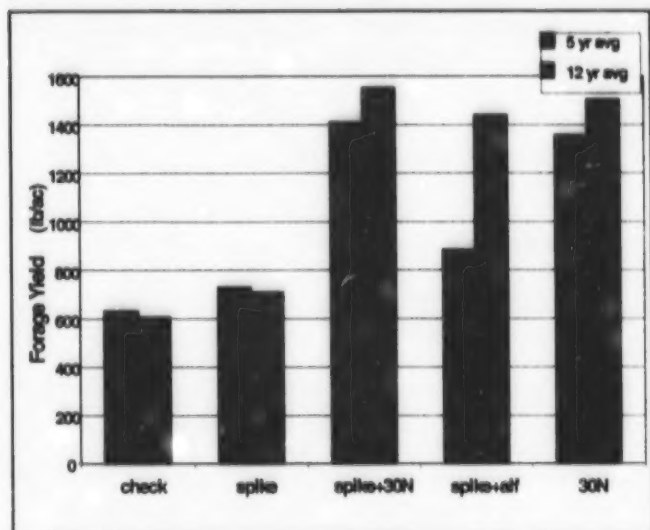


Figure 3. Effects of several treatments over 5 and 12 year periods on crested wheatgrass forage yields. Lorenz and Rogler, 1949-1960, Mandan, N.D. (Spike & spike+alfalfa treatments in Year 1 only; spike+30N & 30N treatments done in spring each year).

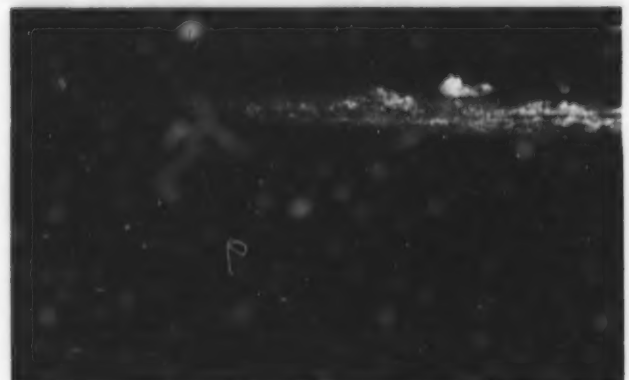
disturbance and the released nitrogen can be used by the forage plants.

- Good soil moisture at the time of mechanical disturbance will also reduce equipment repair costs and roughness of the field following treatment.

FERTILIZATION

Description of Method

- Fertilization involves the application of nutrients to the soil or plants to correct a nutrient deficiency.
- The goal of fertilization is to improve forage yield and/or quality.
- The specific nutrients and amounts required depends on the soil type, average rainfall, soil nutrient status and forage species present in the stand.
- The best practice is to collect soil samples from each field and send them to a lab for analysis and fertilizer recommendations.
- Nitrogen and phosphorus are the most commonly deficient nutrients in perennial forage stands.
- Potassium and sulphur can also be deficient, especially in legume stands on coarse-textured soils.
- It is rare for micro nutrients like boron, zinc and



Effect of N fertilizer on crested wheatgrass.

manganese to be deficient.

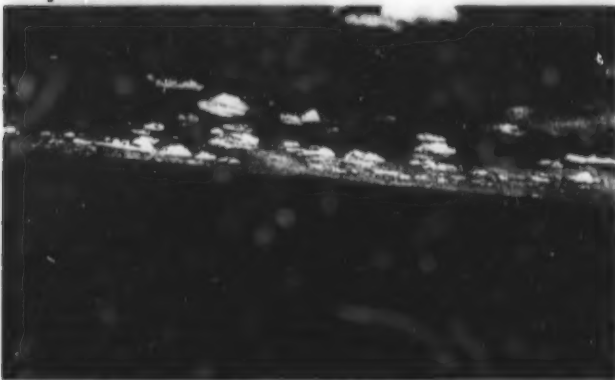
- In grass-legume stands, nitrogen fertilization favours the grasses and phosphorus application favours the legumes.
- Legumes obtain most of their nitrogen needs by fixation if properly inoculated. They provide some nitrogen to surrounding grasses through sloughed nodules. For this reason, including and maintaining

legumes in perennial forage stands reduces the need for nitrogen fertilizer.

Nutrients can be applied to the soil in a number of forms:

Granular fertilizer:

- The most commonly used form for fertilizing perennial forages.
- Widely available and easy to apply compared to other forms of fertilizers.
- Can be broadcast with a fertilizer wagon or banded into the soil using a drill or air seeder.
- Broadcast granules require precipitation to dissolve them and carry the nutrients into the root zone for plant use.



Broadcasting granular fertilizer.

- Because phosphorus does not move with soil water as readily as nitrogen, banding is the preferred method of application if the desire is to have phosphorus available to the plants in the year of application.
- Broadcast phosphorus is not considered available to the plant until the year following application.
- Urea (46-0-0) is the most widely-used form of granular nitrogen fertilizer but has greater losses than ammonium nitrate (34-0-0) when broadcast.
- Up to 20% losses of urea fertilizer through volatilization can occur when it is broadcast on a dry soil surface and remains there for several days during warm, dry, windy weather.

Liquid fertilizer:

- Availability is increasing and its use is becoming more common.

- There are coulter applicators, spoke wheel injectors and banding equipment available for applying liquid fertilizer to perennial forage stands. These implements place the fertilizer in the root zone, reducing the reliance on precipitation to move the nutrients into the root zone.
- Liquid phosphorus fertilizer is available to the plants in the year of application.
- The disadvantage of liquids is the higher cost compared to granular, inconvenience in handling and need for specialized equipment.
- On rough or rocky land, application of liquid fertilizers is only practical with applicators that dribble the liquid on the soil surface. Some losses may occur with this method under, dry warm windy conditions.



Spoke wheel liquid fertilizer applicator.

Anhydrous Ammonia:

- Is an economical form of nitrogen but must be injected below the soil surface and the furrows must be closed to prevent losses of nitrogen to the atmosphere.
- In the past, the furrows created with anhydrous injection on pasture and hayland did not close adequately to prevent considerable losses of nitrogen. New knife-type openers now available seem to minimize this problem.
- On rocky pastures, damage to injection equipment is likely.

Livestock Manure:

- A good source of nutrients and organic matter for perennial forage stands.
- Solid manure can be spread on the land in the fall so there is time for nutrients to be leached into the soil

with precipitation and for soil microorganisms to convert nutrients to forms available for spring growth.

- Liquid manures should be injected into the soil using specialized equipment.
- Manures are relatively low in nutrient content compared to commercial fertilizers, so much larger amounts must be applied to get similar results.

Implications of Using Fertilizer

- 1) Has potential to substantially increase forage yield and quality.
- 2) Has potential to improve condition of forage stand.
- 3) Improvement in forage yield and quality usually lasts at least 2-3 years, depending on amounts of nutrients applied and growing conditions (Figure 4).

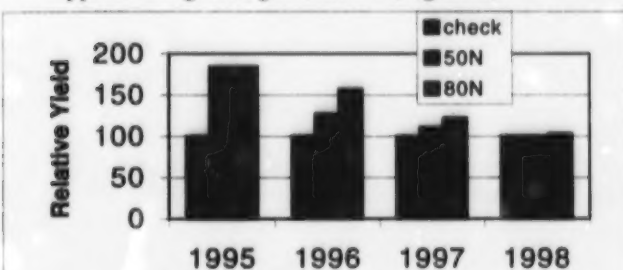


Figure 4. Response of crested wheat grass to fertilizer application in 1995. Meyronne Community Pasture (GAPT data).

- 4) Potential yield improvement is dependent on adequate moisture.
- 5) **Under the right conditions, fertilizer application can be one of the most cost-effective methods of improving forage yield and quality.**
- 6) Response to fertilization is greatest in the year of application provided there is adequate moisture.
- 7) Forage plants use soil moisture more efficiently when nutrients are in balance.
- 8) Livestock tend to avoid areas of pastures spread with manure in the year of spreading.

Changes in Plant Species

- Fertilization tends to favour seeded tame grass species because they respond to nitrogen fertilization with greater growth than most competitor species. This makes it possible to improve the condition of a tame grass stand with fertilization alone.
- **In mixed legume-grass stands, nitrogen fertilization will cause the legume to reduce nodulation, resulting in reduced nitrogen fixation from the atmosphere.** This greatly reduces the need for the legume to supply it's own nitrogen and is a cost that need not be incurred.

- Grasses are better able to use soil nitrate (nitrogen fertilizer) than legumes and therefore will have a competitive advantage over the legume when nitrogen fertilizer is applied. This is likely to reduce the legume component of the stand, reducing forage production and quality over time.

- **Fertilization can be used as a tool to adjust the grass-legume ratio.** Nitrogen application will increase the grass proportion, while phosphorus will increase the proportion of legumes.

Effect on Forage Yield

- Nitrogen is the nutrient that has the most immediate impact on perennial tame grass yield.
- In general, the response to the other nutrients like phosphorous does not occur until nitrogen deficiency has been corrected or exceeded.
- Perennial tame grass yield response to nitrogen application is directly related to growing season soil moisture. In a year of reduced soil moisture, the response to nitrogen application will be less than in a year of better soil moisture.
- The number of years of forage yield improvement following nitrogen application depends on growing conditions in the year of application, as well as the amount of N applied and the grass species.

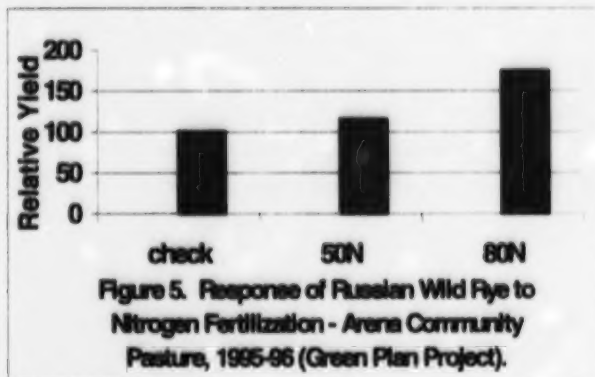


Figure 5. Response of Russian Wild Rye to Nitrogen Fertilization - Arena Community Pasture, 1995-96 (Green Plan Project).

- Rizomatous grasses, like intermediate wheatgrass, appear to show a higher response to nitrogen fertilization than bunchgrasses.
- The degree of response to fertilization varies with grass species. For example, Russian wildrye does not usually respond as well to N application as crested wheatgrass (Figure 5).

Effect on Forage Quality

- Nitrogen fertilization of grasses will increase their protein content, especially early in the growing season (Table 3). It will also lengthen the period during which the grass is palatable to livestock, allowing better use of the forage.
- Phosphorus and potassium levels in the grass can also be improved with nitrogen application if they are not limiting in the soil.

Table 3. Forage quality improvement from application of nitrogen fertilizer (late-season harvest).

TREATMENT	% CRUDE PROTEIN (DM)
Control	5.75
50 lb/ac N	7.63

* Meyronne Community Pasture, 1997 (GAPT data).

- Phosphorus application will improve P levels in forages if the soil is deficient. Phosphorus is a very important element in animal nutrition and is often at marginal levels in livestock diets.

Frequency of Treatment

How often perennial tame forage stands should be fertilized depends on many factors:

- level of nutrient application relative to soil nutrient level; higher levels of fertilization will give longer yield response (Figure 4).
- growing season conditions; the greater the yield response in year one, the less response in year two.
- value of forage relative to the cost of fertilizer: if feed is cheap and fertilizer is expensive, you may be ahead financially by buying feed instead of fertilizing.

Combination of Treatments

- Fertilization enhances the effect of all other rejuvenation methods and can reduce the negative effects of harsh treatments like spiking/or harrowing (Figure 6).
- Application of phosphorus generally improves establishment of new forage plants. If placed with the seed, no more than 15 lb/ac of P should be applied. Higher rates of P can be banded prior to seeding. This will aid in plant root development resulting in rapid initial growth known as a pop-up effect.

When and Where to Use

- Fertilizers are best applied when temperatures are low and the probability of precipitation is high.

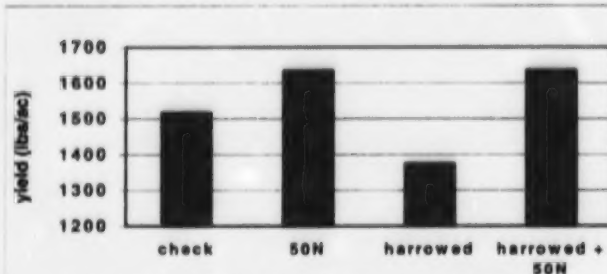


Figure 6. Beneficial effects of combining nitrogen fertilization with harrowing on a crested wheat grass stand. W. Houston, USDA, Miles City, Montana, 1950-52.

- Application is most effective in early spring. Late fall application has also been successful but there tends to be greater losses from runoff and leaching, particularly with N.
- Amounts of nutrients applied should be based on analysis of soil samples.
- In most cases, if desirable plant populations are adequate for the stand to be in at least fair condition, fertilization may be the most cost-effective method for improving forage yield.
- Phosphorus is generally required on forage stands which are more than 4 years old and potassium (K) and sulphur (S) may be required on coarse-textured soils.
- **Legume-grass stands require much less nitrogen fertilization if the legume is properly inoculated, having active root nodules fixing atmospheric nitrogen. Nodules that have a bright pink colour when sliced were actively fixing nitrogen.**
- A nodulation scoring system developed in Alberta has been modified for Southern Saskatchewan conditions. This system can be used to assess whether existing legume forage stands are adequately nodulated for maximum nitrogen fixation.
- Legumes have a high requirement for phosphorus and sulphur, and application of these nutrients, as needed, will help in maintaining legumes in a mixed stand.
- Because the rate of nutrient removal in hay fields is greater than in pasture (some are returned with manure), higher rates of fertilization are required.

IMPROVED GRAZING MANAGEMENT

Description of Method

- Grazing management involves manipulation of the season(s), duration, frequency and intensity of use of pasture forage plants.
- Grazing management can also be changed by use of different livestock species.
- **Stocking rate.** is the number of animals on a specific area for a specific time. Stocking rate is expressed in **animal unit months per acre** or **AUM/acre**. An animal unit month is defined as the amount of forage required to maintain a 1000 lb cow and suckling calf for 30 days. **Manipulation of stocking rate can improve pasture.**
- **Stock density** refers to the number of animals on a given area at a given time. It is expressed as **animals units per acre** or **AU/acre**. **Manipulation of stocking density can be a valuable grazing management tool.**
- With changes in grazing management, pasture in fair condition can be improved over time. The changes can include: changing the season of use; changing the length of the grazing period; changing the number or type of animals used; length of rest periods; improving animal distribution with new water development, changing salting areas and fencing.



Electric fence is an inexpensive tool for improving grazing management.

- The rate of improvement in pasture condition depends on the grazing management changes implemented and growing conditions. Minor changes like shortening the



Water development is a key factor in improving grazing management.

grazing season may only result in slow improvements in condition.

- Major changes like season-long rest can result in rapid improvement in condition.
- A combination of two or more changes in grazing management will usually result in more rapid improvement in pasture condition. (for example: increasing stock density and lengthening the rest period).

Implications of Using this Method

- 1) Short-term stocking rate may be reduced in order to shorten grazing periods or rest pastures.
- 2) May require capital investment (for example: fence, water development).
- 3) Will improve long-term carrying capacity.
- 4) May improve habitat for some wildlife species.
- 5) **Can be one of the least expensive methods of pasture rejuvenation (for example: changing stock density, grazing/rest period, salting points, use of electric fence.**
- 6) Flexibility to change grazing management to fit goals of operation as growing conditions change.
- 7) Grazing of sheep along with cattle in pastures with a high proportion of broad-leaved plants can actually lead to improved forage production for cattle by reducing competition from broad-leaved plants.

Changes in Plant Species

- Providing partial or complete rest to perennial forage plants through improved grazing management will improve their vigor and allow them to become more competitive with undesirable plants.
- Forage stands in at least fair condition, with at least 50% of the forage yield provided by desirable plants, will be given a competitive advantage over less-

desirable plants like bluegrasses, dandelions and pasture sage.



Multi-species grazing can be a valuable tool for improving grazing management.

Table 4. Effect of pasture condition on forage production.

Pasture Condition	Stocking Rate (% of good)
Excellent	133
Good	100
Fair	66
Poor	33

Effect on Forage Yield

- Improved grazing management will, over a period of time, improve forage stand condition. This improved condition will result in improved forage yield.
- The forage production of a pasture in fair condition is approximately 2/3 of the same pasture in good condition (Table 4).
- It will not be possible to return a forage stand in poor condition to good condition with improved grazing management alone, because of the absence of a sufficient population of desirable plants.

Effect on Forage Quality

- Proper grazing management includes using forage plants without damaging them by grazing too early in their growth cycle. It also includes providing sufficient rest following grazing to allow the plant to recover from the stress of being grazed.
- With tame perennial pastures, the goal is to maximize pounds of plant protein harvested per acre. This is

achieved by grazing plants when they are vegetative and maintaining them in a vegetative state through proper grazing management

- When resting a pasture to improve condition, plants will head out and forage quality will decline as the plants mature. Forage quality is reduced during the rest period but is improved together with yield in succeeding grazing seasons as plant vigor is improved.

Application Notes

- Improved grazing management is an ongoing practice that may change over time as conditions change.
- Once pasture condition has been improved to the desired level through improved grazing management it is important that these management changes continue to be applied. If not, the pasture condition will deteriorate much faster than it was improved.

Combination of Treatments

- Improved grazing management should accompany all other rejuvenation methods.
- Fertilized areas should be fenced out of untreated areas as the livestock will congregate on these areas, due to improved quality and palatability.

When and Where to Use

- The need for rejuvenation may be a sign that there is a problem with current grazing management.
- Improved grazing management should be a part of any effort to improve pasture condition.



Crested wheatgrass wolf plants resulting from poor grazing management.

HERBICIDES

Description of Method

- Selective herbicides can be used to kill unwanted plants that are competing with desirable forage species.
- There are a number of herbicides registered for weed control in forage crops. The Recommended Herbicide Chart for forage crops can be found at the back of the Saskatchewan Guide to Crop Protection.
- The Saskatchewan Guide to Crop Protection should be consulted to obtain detailed information on use and restrictions for each herbicide.
- Herbicides can be applied to herbaceous plants using a regular ground sprayer where possible.
- Wick applicators are effective for controlling weeds taller than the forage stand and minimize the amount of herbicide applied, benefiting the environment and improving the economics of weed control.
- Non-selective herbicides can also be used to suppress existing vegetation, enabling introduction of new species to the stand. This will be discussed in the sod-seeding section.

Implications of Using this Method

- 1) Registered products are not available for all 'undesirable' or hard to control species.
- 2) Treatments may be too expensive and/or difficult to carry out.
- 3) Several treatments or follow-up management may be required for effective control.
- 4) Treatment may damage or eliminate some desirable forage species or contaminate soil and water.

Changes in Plant Species

- Herbicide treatments can have a major impact on the plant species in a forage stand.
- Selective herbicides can almost eliminate whole groups of plants allowing other species room to increase and become more dominant.
- Non-selective herbicides can be used to suppress all plants in a forage stand, allowing establishment of new species such as legumes. Unfortunately, invasive weeds can also increase rapidly requiring further herbicide application or other management.



Pasture sage control with 2,4-D (foreground).

Effect on Forage Yield

- One of the main reasons for considering herbicide application is to improve forage yield.
- Pasture sage is the most common 'undesirable' plant in tame forage stands in southern Saskatchewan. Application of herbicide will provide good control resulting in increased yield of the desirable forage (Table 5). The degree of yield increase is dependent on the density of the undesirable plant in the stand prior to spraying and the level of control achieved.

Table 5. Total yield of crested wheatgrass over a 3-year period in response to Pasture Sage control.

Treatment	Forage Yield (lb/ac)	% yield Increase
No treatment	2167	
2,4-D LV 600 @ 1.1 L/ac	2787	29%

* Farm Fact – Management of Pasture Sage, Saskatchewan Agriculture and Food, March 1994.

- Spraying is usually only warranted if the resulting increase in forage yield is worth more than the cost of the herbicide application.
- When controlling woody species, forage yield in the treatment year does not change much due to sustained competition from suckers. In subsequent years, if control measures are continued, forage production will increase as desirable grasses and forbs increase in the stand.

Effect on Forage Quality

- The removal of unpalatable herbaceous or woody species through the use of herbicides will increase

palatable forage species and improve forage nutritive quality.

- Forage quality can also be improved by using spot treatments to avoid wide-spread removal of high quality legumes from the stand. If these species are removed from an existing stand, forage quality will decline.

Frequency of Treatment

The need for re-treatment with herbicides will be reduced if several conditions are met.

- 1) The correct product is used at the appropriate rate and time for the species to be controlled.
- 2) Herbicides are used in combination with other treatments such as mowing prior to herbicide application for control of woody species.
- 3) Proper grazing management is used following herbicide application

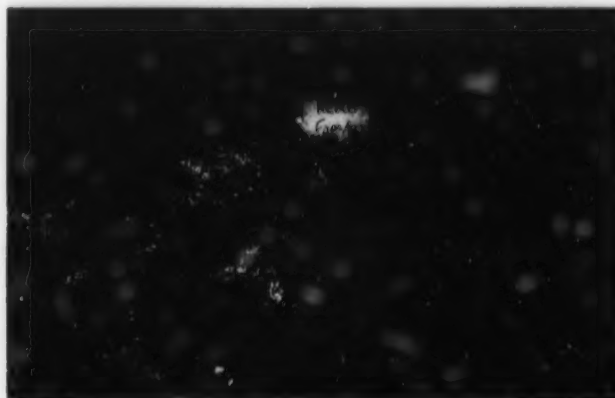
Combination of Treatments

- As mentioned above, a combination of mowing and herbicide application on the re-growth is most effective for control of woody species.
- **A herbicide application may be necessary following mechanical disturbances like spiking or breaking and re-seeding where high levels of disturbance create openings in the forage stand for weeds to invade. In this case, selective herbicides that are effective on the most persistent competitive weeds, are the best choice**
- Use of a non-selective herbicide in combination with sod-seeding can be a successful method of stand

rejuvenation under the right conditions. See the sod-seeding section.

When and Where to Use

- Herbicide application should be made when the target plant is most susceptible. For most shrubs and annual weeds this is when they are actively growing. For perennial weeds, herbicide application in summer or early-fall is often most effective.
- Biological control of undesirable species may be considered for such species as leafy spurge and scentless chamomile.
- **Herbicides should be used on forage stands that have good desirable plant density but are not producing at their potential due to competition from undesirable plants. The cost of the herbicide application must be weighed against the estimated loss in forage yield and quality due to the undesirable plant infestation.**

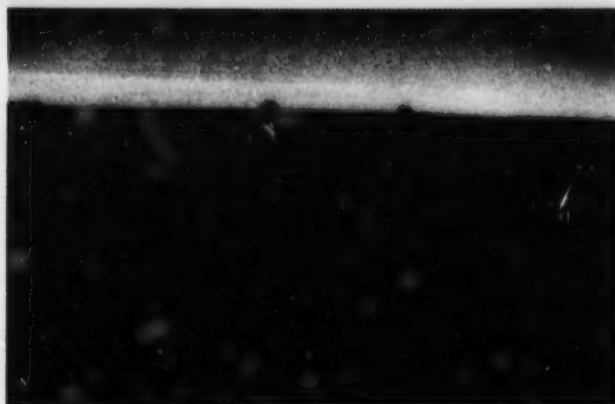


Foxtail barley control with Kerb®.

SOD SEEDING

Description of Method

- Sod-seeding is the seeding of forage species into an existing perennial forage stand without breaking up the sod.
- First, a non-selective, non-residual herbicide such as glyphosate is sprayed to kill the existing vegetation.
- Once it has been determined that vegetation control is adequate, forages are sod-seeded using an appropriate seeding implement.
- Triple disc drills work best for sod-seeding. They use one disc in front to cut the so and a double disc opener



Sod seeding used to introduce new species.

to place the seed in the furrow.

- Any single or double disc drill that can penetrate the sod and place the seed in the soil will do the job.
- Most seeders with narrow openers, suited to minimum or zero tillage systems can be successfully used for sod-seeding



Cutting disc to open sod for sod seeding.

- Shallow seeding, accurate seed metering and good packing to close the furrow are critical in sod-seeding.
- Leveling of the ground following sod seeding is not necessary when the seeding equipment causes minimal disturbance to the soil surface.
- Sod-seeding without the use of herbicide is very unlikely to be successful.



Depth bands on discs to control seeding depth.

Implications of Using this Method

- 1) There is less risk of wind and water erosion when a pasture is improved with sod-seeded compared to breaking and re-seeding
- 2) Can be an effective and economical method of establishing productive forage species in an old stand (Figure 7).
- 3) Forage production on the rejuvenation site is lost for at least one season.

- 4) If herbicide application is not effective in killing most of the existing vegetation, or the growing conditions are poor, the sod-seeding will be unsuccessful. This will require re-spraying and re-seeding and result in more than one season with no forage production from the field.
- 5) Effectively conserves soil moisture beneath sod.

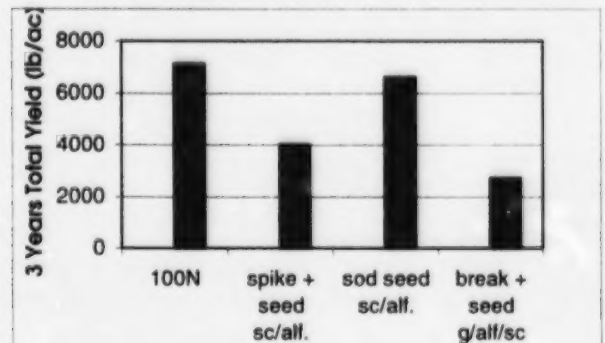
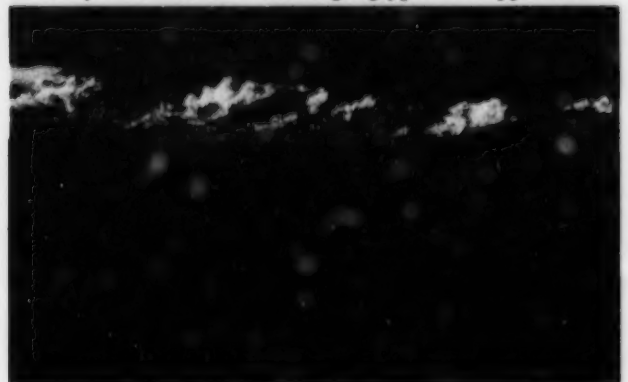


Figure 7. Comparison of sod seeding with other rejuvenation treatments on crested wheatgrass. (SPARC 1995-97).

(Sweet clover/alfalfa, grass/alfalfa/sweet clover).

Changes in Plant Species

- Plants not controlled by glyphosate, may increase after a herbicide application.
- In sod seeding trials, pasture sage was a minor species in a crested wheatgrass stand but increased dramatically after glyphosate application. Other perennial species like Canada thistle and sow thistle may also increase following a glyphosate application.



Good vegetation control is critical to successful sod seeding.

Effect on Forage Yield

- If more productive forage species are sod-seeded than those that existed in the stand prior to spraying, the forage yield of the stand should increase.

- If a poor condition pasture is successfully sod-seeded, its condition will improve.

Effect on Forage Quality

- Replacing pure grass stands with legumes or grass-legume mixtures will greatly improve forage yield and quality.

Frequency of Treatment

- A sod-seeded forage stand should remain productive for many years as long as the species seeded are well adapted to the site. Use of proper grazing, haying and soil fertility management practices will ensure long life.

Combination of Treatments

- Sod seeding is most successful in the long term if

combined with improved grazing management and fertilization.

When and Where to Use

- Sod-seeding is usually done on a forage stand that is in poor condition.
- As with most other rejuvenation methods, moisture is the key to success with sod-seeding.
- Spring-applied glyphosate followed by sod seeding during the time of highest probability of rainfall will improve the chance of success.
- Fall-applied glyphosate has been shown to be more effective for control of smooth brome and bluegrasses.

OVER SEEDING

Description of Method

- Over seeding involves broadcasting forage seed onto an existing pasture or hay stand to improve forage production and quality.
- Sometimes the stand is harrowed, spiked, or rolled with a land roller following broadcasting of the seed to improve seed contact with the soil.
- Relatively inexpensive, small-seeded species like alfalfa and clovers are the species most commonly over seeded.
- Seeding rates for the legumes are usually $\frac{1}{2}$ to $\frac{3}{4}$ of the normal rates.
- Small-seeded grasses can also be over seeded with some success.

Implications of Using this Method

- 1) Can be an inexpensive method of establishing a legume in a grass stand.
- 2) Vigorous harrowing or spiking after broadcasting will likely result in a reduction in forage production in the year of treatment.
- 3) Establishment success is very weather dependent.
- 4) The more bare ground the better the chance of establishment by overseeding.

Changes in Plant Species

- Can be an effective method of increasing the legume component of a mixed stand or introducing a legume to a grass stand.



Heavy harrows with mounted Valmar® for over seeding.

Effect on Forage Yield

- Yield increases are very dependent on the amount of broadcast forage that establishes.
- Soil moisture, competition from existing forage plants and suitable germination sites for the seeds are all factors that will affect the time required for establishment and subsequent yield.
- Successful establishment of 1-2 legume plants per square meter will significantly improve yield of the forage stand.

Effect on Forage Quality

- Forage quality will be greatly improved wherever a legume is successfully established in a grass stand.

Frequency of Treatment

- Over seeding of legumes on tame forage stands can be done when the legume component of the stand has fallen to a low proportion or disappeared.

Combination of Treatments

- Herbicide application or soil disturbance such as spiking combined with over seeding will reduce competition from existing plants and provide germination sites for broadcast seeds.
- Soil disturbance will also encourage germination of weed seeds present in the soil possibly resulting in overgrowth of weedy species.
- Soil disturbance will not guarantee successful establishment of the over seeded species. It may actually hinder establishment under some conditions.

When and Where to Use

- Over seeding should be done as early in the spring as possible so that germination takes place during cool, moist soil conditions.
- Dormant seeding in the fall is also an option for most legumes except sweet clover. Sweet clover seed loses viability over winter.

- Establishment will be best in moist years.
- Do not fertilize grass stands in the year of over seeding legumes as this will increase the competition from the existing grasses and weeds.
- Over seeding can be used on highly erodible sites to reduce the risks associated with high disturbance rejuvenation methods.
- Broadcasting alfalfa onto an alfalfa stand to thicken the stand is usually unsuccessful. This is because of a chemical released by alfalfa plants into the surrounding soil that suppresses germination of alfalfa seeds, reducing competition.
- Over seeding is best suited to grass stands where there is enough bare ground to provide room for establishment of new seedlings.
- Overseeding is a possible option for soils with high stone content.

MOWING

Description of Method

- A rotary flail or sickle mower is used to remove plant growth to a 3-4 inch height.
- **Mowing is most commonly used to remove unwanted vegetation such as weeds or brush or to cut and mulch a large amount of old growth.**
- A swather can be used where vegetation is not woody and mulching is not necessary.
- Removal of woody plants or weeds by mowing or swathing can provide a competitive advantage to desirable forage plants.
- Rotary mowers can effectively shred woody plants up to 6 feet tall.

Implications of Using this Method

- 1) Hard on equipment when used on rough terrain.
- 2) Too expensive and time consuming on large areas.
- 3) May waste useable forage.
- 4) Requires follow-up treatment.
- 5) Will increase suckering of trees and shrubs.
- 6) Improvements in yield are minimal in some situations.
- 7) **Swathing or mowing of woody plants leaves a sharp stump that can cause injuries to cattle, horses and damage to tires on equipment.**

Changes in Plant Species

- A single mowing will have limited impact on the proportion of plant species in a stand. Mowing to control weeds will favor species with faster re-growth. When mowing to remove old growth or woody plants, species which prefer direct sunlight will be favored. Shade tolerant species, such as Kentucky bluegrass, will lose their competitive advantage over the more desirable tame species.
- **Control of woody plants may mean a reduction in wildlife browse supply and cover.**

Effect on Forage Yield

- When removing old plant material from overgrown stands, forage availability will be reduced for the first year due to loss of this material.
- Mowing to control woody plants may increase palatable forage production in the year of mowing.
- The amount of increase in desirable forage and the number of years it will remain will depend on the condition of the stand prior to mowing or swathing and management of the stand following treatment.

Effect on Forage Quality

- Mowing can improve forage quality by removing unpalatable species or dead material which should be replaced with new growth of desirable forage species.

- The direct effects of mowing on the quality of forage grasses and legumes are minimal.

Frequency of Treatment

- Woody species will require re-treatment as they will sucker after being mowed.
- **Mowing two years in succession is much more effective for woody plant control than only one mowing followed by a second mowing several years later. Both mowings could also be done in the same year if re-growth occurs.**
- **A combination of treatments including herbicide and mowing, along with good grazing management should suppress woody species for several years.**
- Re-treatment should not be necessary when mowing or swathing is used to remove weeds or accumulated dead forage material. By implementing improved grazing management practices the problem can usually be prevented from recurring.

Combination of Treatments

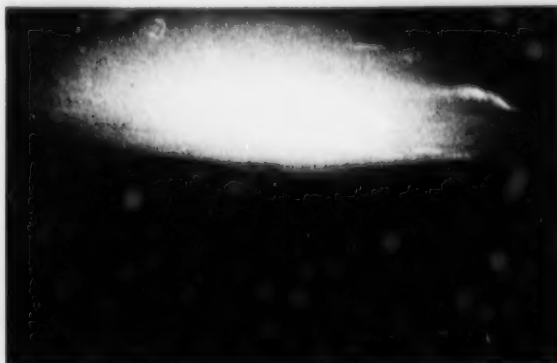
- **Use of several methods of rejuvenation is most effective for controlling weedy herbaceous and woody plants and eliminating excessive buildup of dead plant material.**
- As mentioned earlier, woody species should receive a second mowing or herbicide treatment in the year following mowing. Small suckers can be effectively controlled with herbicide. (See the 'Saskatchewan Guide to Crop Protection' for herbicide and rates).
- Following mowing, cattle will browse new suckers of most woody species if stocking density is high enough to reduce their ability to selectively graze. By having cattle present in these areas only for short periods of time, over-grazing of the grasses can be avoided.

- **Use of cattle for control of woody suckers should start in the year of mowing and be repeated as part of a new grazing management plan.**

- Forage stands that have been rested for a long period of time will build-up a thick thatch. Using high stock density with or without mowing or swathing, will open up the thatch allowing sunlight to penetrate to emerging tillers.

When and Where to Use

- Mowing is most commonly done where woody species are encroaching into pastures.
- A swather or sickle mower can be used to remove weeds or accumulated old growth.
- **Mowing of woody species and excessive old growth should take place in the spring to prevent the removal of new desirable plant growth.**
- Mowing should not be done in the fall as the woody suckers and old growth act as a snow trap providing valuable moisture for the following year.
- Mowing or swathing annual weeds is most effective in early summer when their root reserves are lowest and prior to seed being set.
- Perennial weeds should be cut before flowering and again later if re-growth occurs.
- Removal of a large portion of the 'undesirable' plant's leaves will result in the best suppression.
- The combination of low root reserves, slow re-growth and reduced leaf area of weedy species following cutting should give perennial forage plants a competitive advantage.



COSTS AND BENEFITS OF REJUVENATION OPTIONS

Estimated costs for the various rejuvenation methods are detailed on the next page. Rejuvenation costs are relatively simple to calculate. 1998 custom rates have been used for all operations and current costs for seed and fertilizer at the time of writing. Producers should adjust these costs to reflect their actual costs at the time of considering a rejuvenation method. An accounting should also be done for the loss of production during rejuvenation practices.

Unlike rejuvenation costs, benefits from rejuvenation are difficult to predict. For some treatments, data on yield response is available for the brown and dark brown soil zones and is used in the cost/ benefit analysis. For rejuvenation methods where appropriate data are not available, we will either use conservative estimates of yield responses or leave the analysis out.

A cost/benefit analysis was not done for improved grazing management. There are too many variables to provide a

Producers should adjust these costs to reflect their actual costs at the time of considering a rejuvenation method. An accounting should also be done for the loss of production during rejuvenation practices.

general net benefit or loss. For individual operations, the costs of making changes to grazing management are usually very small unless fencing and water development are required. The dollar value of the benefit from improved grazing management is not easy to calculate. However, if the costs are small, perhaps only requiring a change in the season of use or stocking density, improved

grazing management will always result in a significant net benefit to the long-term bottom line of the operation. In many cases, even if a change in grazing management requires the

capital cost for development of water and/or fencing, there can still be a net financial benefit to the operation over time.

Improved grazing management may be the easiest and most cost-effective tool for increasing forage production. Contact your nearest Rangeland/Forage Agrologist for assistance and information on grazing management of tame and native forages.



Treatment Cost Assumptions

Operation	Our Cost \$/ac	Your Cost \$/ac	Operation	Our Cost \$/ac	Your Cost \$/ac
Spiking or Knifing			Deep Band Fertilizer		
Cost: 1 pass with heavy duty cultivator	4.50	_____	Cost: 150 lb. 40-10-0 blend @ \$285/ton	21.00	_____
Aerway or Rotary Harrowing			Application with bander	7.00	_____
Cost: 1 pass	4.00	_____	Total	28.00	_____
Mowing			Break and Re-seed		
Cost: 10 ft. mower @ 5 ac/hr (\$56.00/hr)	11.20	_____	Cost: Year 1		
Burning (based on 160 ac burn)			Work field in fall twice with tandem disc		
Cost: Discd fireguard	0.50	_____	2 operations @ \$6.75	13.50	_____
Equipment & labour	2.00	_____	Cost: Year 2		
Total	2.50	_____	Cultivate and seed to greenfeed oats		
Sod Seeding			(1 cultivation operation @ \$4.50/ac)	4.50	_____
Cost: Herbicide	10.00	_____	(1 operation air seeder @ \$8.50/ac)	8.50	_____
Seeding (zero-till disc drill)	14.00	_____	(2 bu. Oats/ac @ \$2.00/bu)	4.00	_____
Seed: 1 lb. Alfalfa @ \$3.00/lb.	3.00	_____	Swathing and baling of greenfeed	26.00	_____
4 lb. crested wheatgrass @ \$2.50/lb.	10.00	_____	Cost: Year 3		
Total	37.00	_____	Spring glyphosate burnoff	10.00	_____
Over-seeding Legumes			Seed - 4 lb. crested wheatgrass @ \$2.50/lb.	10.00	_____
Assumes: Broadcast alfalfa at normal seeding rate and harrow.			- 1 lb. Alfalfa @ \$3.00/lb.	3.00	_____
Cost: Seed- 2 lb. @ \$3.00/lb.	6.00	_____	Seeding - 1 operation with air seeder	8.50	_____
Seeding- broadcast application	2.20	_____	Total	87.50	_____
Harrowing	1.50	_____			
Total	9.70	_____			
Broadcast Fertilizer					
Cost: 150 lb. 40-10-0 blend @ \$285/ton	21.00	_____			
Application	2.50	_____			
Total	23.50	_____			

Information in the following table is based on data gathered from several studies on rejuvenation of crested wheatgrass. The studies took place in various locations including Mandan, North Dakota; Miles City, Montana; Swift Current, Saskatchewan; other locations in southwestern Saskatchewan. For some rejuvenation methods, there is no good data on their beneficial effects, so it is not possible to estimate the expected net returns.

Table 6. Net Return per acre totaled over three years for rejuvenation options.(alfalfa-grass hay value \$60/t, grass hay value-\$50/t; greenfeed value-\$40/t)

Rejuvenation Method	Forage Production Change - %		Forage Production Change - lb/ac		Value of forage production change - \$/ac		Cost of rejuvenation method - \$/ac		Net return of rejuvenation method - \$/ac	
	example	Yours	example	Yours	example	Yours	example	Yours	example	Yours
Spike	Yr 1-10-20% Yr 2+10-30% Yr 3 +5-10%		156		2.60		4.50		-.60	
Knife/Aerway/ Rotary harrow	---		---		---		4.50		N/A	
Mow	7		84		2.10		11.20		-9.10	
Burn	--		---		---		2.50		N/A	
Sod seed (grass-legume mix)	Yr. 1 +40 Yr. 2 +45 Yr. 3 +45		1600		48.00		37.00		+11.00	
Over seed	---		---		---		9.70		N/A	
Broadcast Fertilizer (150lb/ac 40-10-0)	Yr. 1 +80 Yr. 2 +40 Yr. 3 +15		1600		40.00		23.50		+16.50	
Deep band Fertilizer (150lb/ac 40-10-0)	Yr. 1 +80 Yr. 2 +40 Yr. 3 +15		1600		40.00		28.00		+12.00	
Break & re-seed - Forage - greenfeed	Yr. 1 +GF Yr. 2 +50 Yr. 3 +50		1500 600 600		40.00 15.00 <u>15.00</u> <u>70.00</u> (no nurse crop 30.00)		87.50		-17.50 (no nurse crop -57.50)	
Improved grazing management	—		—		—		—		N/A	

Ranking of Preferred Rejuvenation Methods to Achieve Different Management Goals (for information on 'burning' see *Rejuvenation of Tame Forages: PARKLANDS*)

Management Goal	Best Choice of Rejuvenation Methods in order of preference
Increase grass forage production.....	1) Fertilization and Improved Grazing Management. 2) Fertilization alone. 3) Spike or Knife and Improved Grazing Management.
Improve quality of grass forage production..	1) Fertilization and Improved Grazing Management. 2) Fertilization alone. 3) Fall Burning.
Improve condition of grass stand.....	1) Improved Grazing Management. 2) Fertilization and Improved Grazing Management. 3) Fertilization, Improved Grazing Management and Herbicide application. 4) Sod-seeding.
Increase proportion of alfalfa	1) Improved harvest/grazing management and phosphorus fertilization. 2) Over-seeding. 3) Sod-seeding. 4) Burning and Improved Grazing Management.
Decrease proportion of alfalfa.....	1) Nitrogen fertilization. 2) Herbicide application.
Change species of stand.....	1) Sod –seeding. 2) Break and re-seed.
Weed control.....	1) Improved Grazing Management. 2) Herbicide application and Improved Grazing Management. 3) Mowing and Improved Grazing Management. 4) Burning and Improved Grazing Management. 5) Sod-seeding. 6) Break and re-seed.
Brush control.....	1) Improved Grazing Management 2) Mowing, Improved Grazing Management and herbicide. 3) Burning, Improved Grazing Management and herbicide. 4) Burning, Improved Grazing Management and mowing.
Old growth removal.....	1) Improved Grazing Management. 2) Mowing or haying and Improved Grazing Management. 3) Mowing and rotary harrow. 4) Burning.

*Rankings based on economics, effectiveness and practicality of rejuvenation methods.

FURTHER READINGS AND REFERENCES

Abouguendia, Z. 1999. Re-grassing Farmland: A Practical Guide to Selecting the Right Forage Species. Grazing and Pasture Technology Program.

Bowes, G. 1996. Pasture Improvement with Sod Seeding. Agriculture and AgriFood Canada.

Dodds, D.; Van Der Puy, D.L., 1985. Grassland Renovation. North Dakota State University, Co-operative Extension Service, NDSU, Fargo, ND.

Farm Machinery Custom and Rental Rate Guide, 1998 . Saskatchewan Agriculture and Food.

Fertilizing Tame Pastures in Saskatchewan, 1997. Grazing and Pasture Technology Program (GAPT).

Grazing Systems for Rangelands of Southern Saskatchewan. Grazing and Pasture Technology Program (GAPT).

Guide to Crop Protection, 1999. Saskatchewan Agriculture and Food.

Hodgson, J. 1990. Grazing Management: Science into Practice. Longman Group.

Houston, W.R. , 1957. Renovation and Fertilization of Crested Wheatgrass Stands in the Northern Great Plains. USDA, Miles City, MT.

Intensive Management of Livestock Grazing, 1993. Farm Fact, Saskatchewan Agriculture and Food.

Lodge, R.W. , 1960. Effects of Burning, Cultivating and Mowing on the Yield and Consumption of Crested Wheatgrass. Agriculture Canada Research Station, Swift Current, SK.

Lorbeer, S.; Jacobsen, J.; Houlton, H.; Lund, D.; Martin, J.; Carlson, G. , 1994. Nitrogen Fertilization of Dryland Grasses. Montana AgResearch.

Lorenz, R.J. , Rogler, G.A. , 1961. A Comparison of Methods of Renovating Old Stands of Crested Wheatgrass. USDA Northern Great Plains Field Station, Mandan, ND.

Management of Pasture Sage, 1994. Farm Fact, Saskatchewan Agriculture and Food.

Nutrient Values of Manure, 1997. Farm Fact, Saskatchewan Agriculture and Food.

Rejuvenation of Old Crested Wheatgrass Pasture, 1998. Meyronne Community Pasture, Canada-Saskatchewan Agriculture Green Plan Agreement/GAPT Project.

Rejuvenation of Tame Forages: PARKLANDS. 1997. Saskatchewan Agriculture and Food.

Schellenberg, M.P. , 1998. Pasture Renovation Systems, Pasture and Hayfield Rejuvenation, Final Report;., Semiarid Prairie Agriculture Research Station, Swift Current, SK.

Species Selection Criteria for Seeding Dryland Pastures in Montana, 1996. Montana State University, Extension Service, Bozeman, MT.

Tremblay, M. 1999 Saskatchewan Forage Crop Production Guide. Saskatchewan Agriculture and Food.

Tremblay, M. and B. Kirychuk, 1998 Initial Stocking Rate Recommendations for Seeded Forages in Saskatchewan. Farm Fact, Saskatchewan Agriculture and Food.

Waller, S.S. ; Moser, L.E. ; Reece, P.E. , 1985. Understanding Grass Growth: The Key to Profitable Livestock Production. Trabon Printing Co., Inc. 430 East Bannister Road, Kansas City, Missouri 64131.